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CORRELATION OF THE EARLY SILURIAN ROCKS IN THE HUDSON BAY REGION¹

T. E. SAVAGE

University of Illinois, Urbana, Illinois

The oldest rocks of Silurian age known in the Hudson Bay region are present in the banks of Nelson River, about forty-five miles above tide-water. The best exposure is about four miles below the outcrop of Richmond strata at the lower Limestone Rapids of the river, where a vertical ledge outcrops to a height of 28 feet above low water. The rocks are nearly horizontal or gently undulating, and consist of yellowish-brown, rather fine-grained dolomite, in layers 4 to 10 inches thick. Masses of this dolomite form a pavement along the banks of the river at intervals for several miles below the main exposure, indicating that the river is actively cutting into these strata in places east of their actual outcrop.

The fossils in this dolomite appear to be restricted to a narrow zone in the lower part of the bed. The most abundant are molds and casts, mostly of the ventral valve, of shells of the species described by Whiteaves as *Conchidium decussatum* from the basal Silurian strata at the Grand Rapids of Saskatchewan River. These shells are in places so crowded together as to make up the greater part of the rock layers, just as they occur at the Grand Rapids outcrop, where they are also restricted to a narrow zone.

The shells of this species found in the Nelson River region show a wide variation in the ratio of their length and width, in the degree of convexity or galeation of the ventral valve, and in the development of the mesial fold on the ventral valve. Some of the partially exfoliated shells even show a distinct mesial sinus extending from the beak over the umbonal region of the ventral valve, which becomes obsolete or is transformed into a mesial fold in the middle

¹ The strata discussed in this paper probably fall within the later half of the Oswegan series of the New York Classification.

and anterior portions of the valve. Similar variations occur in the shells of this species found at the Grand Rapids of the Saskatchewan River, described by Kindle¹ as follows:

Conchidium decussatum belongs to a group of shells in which the specific characters are very plastic. . . . The ventral valve shows three well-marked types of contour, viz.: (1) Strongly convex with a more or less clearly defined median ridge extending from the umbonal region to the front of the shell. (2) Very convex with tumid umbonal region rounding regularly from the median region to the lateral and anterior margins without trace of median ridge. (3) Strongly convex in median and anterior region with or without median ridge, but with a broad shallow sinus extending from the beak across the umbonal region. These three types of contour make striking contrasts when individuals in which they are best developed are compared; but the intermediate forms, in which neither the presence of ridge or sinus nor their entire absence can be positively stated, make difficult any attempt to discriminate them as distinct varieties.

It is noteworthy that the shells showing a mesial sinus in the umbonal region of the ventral valve are young forms, and the writer is convinced that the more striking differences shown in the ventral valve of this species represent different growth stages in the individuals; the youthful stages show a mesial sinus from the beak across the umbonal region or farther anteriorly, while in the old stages the mesial sinus has disappeared and a distinct mesial fold is frequently developed.

The above-mentioned characters are the principal ones on which Twenhofel founded the genus *Virgiana*, and it seems certain that the species formerly known as *Conchidium decussatum* really belongs to the genus *Virgiana*. Through the kindness of Dr. Kindle a comparison was made of the shells of this species from Nelson River with those from the Saskatchewan region in order to make sure of the identity of the species from the two localities. The shells from the Grand Rapids locality also show unmistakably the characters of the genus *Virgiana*² to which this species is here referred.

¹ E. M. Kindle, "Notes on the Geology and Paleontology of the Lower Saskatchewan River Valley," *Geol. Surv. of Canada, Mus. Bull. No. 21* (Geol. Series No. 30), October 14, 1915, p. 16.

² Specimens of these shells were also sent to Dr. Twenhofel, the author of the genus, who agreed with the writer that they were true *Virgianas*.

The variation presented in the ventral valve of this species is similar to that shown in the shells described by the writer as *Virgiana barrandei* var. *mayvillensis*, and *V. barrandei* var. *major* from the Mayville limestone in Wisconsin. At the time those varieties were described the only other known representatives of this genus were *Virgiana barrandei* and a variety of that species occurring in the Becsle River (earliest Silurian) formation of Anticosti Island, from which it was thought that they might have been derived. However, the *Virgiana* shells from Wisconsin are now known to be more closely related to *Virgiana decussata* than to the Anticosti forms. In recognition of this relationship it is here proposed to elevate the varieties *Virgiana barrandei* var. *mayvillensis* and *Virgiana barrandei* var. *major* to the rank of species. The former differs from *Virgiana decussata* in having somewhat fewer and coarser radiating plications, less numerous concentric markings, and usually is relatively wider in the anterior part of the shell. *Virgiana major* is a larger shell than *V. decussata*, and generally has a much more strongly developed keel-like median ridge on the ventral valve.

Regarding the age of the strata containing these shells in the Grand Rapids region Kindle¹ says:

Close comparison between the faunas of the Grand Rapids section and those of eastern Silurian sections, owing to the dearth of common species, is difficult. The dominance in the lowest (Silurian) fauna of this section of such a genus as *Conchidium*, however, makes it probable that the base of the section represents a Silurian horizon not earlier than the Clinton, and probably of early Niagaran age.

This argument is no longer applicable, since instead of belonging to the middle Silurian genus *Conchidium*, the species in question belongs to the genus *Virgiana*, which is an early Silurian genus known elsewhere only from strata of pre-Niagaran (Alexandrian) age.

The early Silurian age of the strata containing *Virgiana decussata* in the Grand Rapids of the Saskatchewan and the Hudson Bay regions can be shown by their relations to associated strata in different areas. In the Grand Rapids region the layers containing *Virgiana decussata* are succeeded by strata which contain the fossils

¹ E. M. Kindle, *op. cit.*, p. 9.

Pterinea occidentalis, *Isochilina grandis* var. *latimarginata*, and *Leperditia hisingeri* var. *fabulina*. In the Hudson Bay region a zone a few feet above the horizon of *Virgiana decussata* furnished shells of *Camarotoechia?* *winiskensis*, *Pterinea occidentalis*, *Isochilina grandis* var. *latimarginata*, and *Leperditia hisingeri* var. *fabulina*. In the northern peninsula of Michigan¹ early Silurian strata containing *Camarotoechia?* *winiskensis*, *Isochilina grandis* var. *latimarginata*, and *Leperditia hisingeri* var. *fabulina* overlie the strata containing *Virgiana mayvillensis*, which is a near relative of *Virgiana decussata*. In eastern Wisconsin *Virgiana mayvillensis* occurs in the uppermost layers of the Mayville limestone above which there is a stratigraphic break, the horizon of *Camarotoechia?* *winiskensis*, *Isochilina grandis* var. *latimarginata* and *Leperditia hisingeri* var. *fabulina*, present farther east in northern Michigan, having been removed by erosion. However, there is no doubt that the strata which in northern Michigan contain *Virgiana mayvillensis* correspond in age to those containing the same species in the upper part of Mayville limestone in Wisconsin, as they are clearly a north-eastward continuation of the same beds. The relations of the strata containing *Virgiana* to the overlying and underlying beds in the regions above described are shown in the columnar sections in Fig. 1.

In Wisconsin there was found in the quarry near Peebles a zone only a few feet below the horizon of *Virgiana mayvillensis* and apparently conformable with it, which yielded such characteristic Edgewood species of fossils as *Dalmanella edgewoodensis*, *Rhynchonella?* *janea*, *Rhynchotreta parva*, and *Atrypa putilla*. The position of *Virgiana mayvillensis* in Wisconsin in the upper part of the Mayville limestone, which at a slightly lower level contains a characteristic Edgewood fauna, indicates that this horizon is Alexandrian (late Edgewood) in age. It is also significant that the strata containing *Virgiana mayvillensis* in Wisconsin seems to occupy about the same position in the Silurian column as do the strata which contain *Virgiana barrandei* in the Becsie River formation of Anticosti Island.

¹ T. E. Savage and H. F. Crooks, "Early Silurian Rocks of the Northern Peninsula of Michigan," *Am. Jour. of Science*, XLIV (January, 1918), 59-64. In the lists of fossils given in this paper the name of the species given as *Atrypa putilla* should have been written aff. *Atrypa putilla*.

CHART SHOWING RELATIONS OF EARLY SILURIAN STRATA
CONTAINING VIRGINIA IN DIFFERENT REGIONS

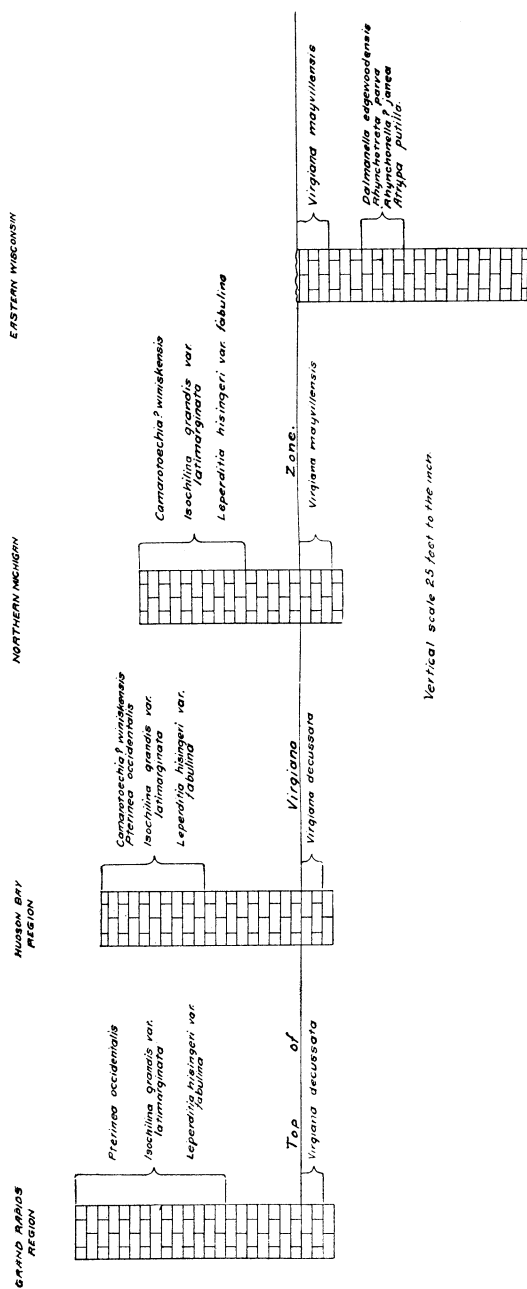


FIG. 1

In Michigan the strata containing *Camarotoechia? winiskensis*, *Isochilina grandis* var. *latimarginata*, and *Leperditia hisingeri* var. *fabulina* conformably overlie the *Virgiana mayvillensis* beds, and thus are thought to correspond in age to about that of the Sexton Creek or Kankakee limestone which overlies the Edgewood in Illinois and Missouri, but they were deposited in a different geologic province.

The close correspondence in the fauna of the strata overlying the *Virgiana mayvillensis* zone in northern Michigan with that of the strata above the horizon of *Virgiana decussata* in the Hudson Bay and Saskatchewan regions leaves no doubt of the equivalence of the strata containing this fauna in the areas above mentioned. They also prove that the *Virgiana mayvillensis* zone in Wisconsin and Michigan, and the *Virgiana decussata* zone in the Hudson Bay and Saskatchewan localities represent the same stratigraphic horizon.

Besides the above-mentioned localities Hume¹ has found early Silurian strata containing *Camarotoechia? winiskensis*, and numerous ostracods in the Lake Timiskaming area that he correlates with the Cataract formation, which doubtless corresponds with the *Camarotoechia? winiskensis*, *Isochilina*, and *Leperditia* horizon in the regions above described. The age assigned to this horizon by Hume agrees with that given by the writer above.

Kindle² found Silurian strata several hundred miles north of the Grand Rapids locality, in the vicinity of the Pas, from which he obtained the fossils *Camarotoechia? winiskensis*, *Pterinea* cf. *occidentalis*, and *Leperditia* cf. *hisingeri*. This fauna also indicates a horizon about equivalent to that of the Silurian in the Lake Timiskaming region and to the strata containing *Pterinea occidentalis*, *Isochilina*, and *Leperditia*, above the *Virgiana decussata* horizon in the Grand Rapids section, the latter horizon not being exposed in the more northern locality. From the similarity in the faunas of the *Virgiana* zone, and of the higher strata containing

¹ G. S. Hume, "Paleozoic Rocks of Lake Timiskaming Area, *Geol. Surv. of Canada, Sum. Rept.* (1916), pp. 188-92. Fossils reported by Charles Schuchert in a personal letter.

² E. M. Kindle, *op. cit.*, p. 12.

Camarotoechia? winiskensis, *Isochilina grandis* var. *latimarginata*, and *Leperditia hisingeri* var. *fabulina* in the regions above described it is inferred that during the time these strata were laid down the above-mentioned regions were a part of the same province or basin of deposition, which was rather broadly connected northward with the Arctic Ocean.

This extensive northern invasion, together with the nearly synchronous deposits of the Cataract formation in a basin connected eastward with the Gulf of St. Lawrence region, and of the Brassfield and Sexton Creek limestones which were deposited in a southern basin, indicates a much more extensive submergence of the continent during early Silurian (late Alexandrian) time than was formerly supposed.

The very close correspondence of the middle and late Ordovician and early Silurian rocks and faunas in the Saskatchewan and Hudson Bay regions is strong evidence that they were deposited in a sea that was continuous between these areas. The presence of middle Ordovician and early Silurian rocks and faunas in the Lake Timiskaming region¹ similar to those in the Hudson Bay region, and of late Middle and Upper Devonian strata in the vicinity of James Bay which probably originally extended south to the Timiskaming region,² indicates that this part of the ancient Laurentian or Canadian shield did not exist continuously as a land surface throughout the Paleozoic era, as has generally been assumed, but that during middle and late Ordovician time, in early Silurian, and probably also during late Middle and Upper Devonian time the northern seas, temporarily at least, covered the greater part of this shield on the south and probably also on the west of Hudson and James bays. Kindle and Burling³ have previously shown that the seas probably also extended widely over the Laurentian upland southeast and east of Hudson Bay during the Paleozoic era.

¹ M. Y. Williams, "The Ordovician Rocks of Lake Timiskaming," *Geol. Surv. of Canada, Mus. Bull. No. 17* (Geol. Series No. 27), June 7, 1915.

² G. S. Hume, "Paleozoic Rocks of Lake Timiskaming Area," *Geol. Surv. of Canada, Sum. Rept.* (1916), p. 190.

³ E. M. Kindle and L. D. Burling, "Structural Relations of the Pre-Cambrian and Paleozoic Rocks North of the Ottawa and St. Lawrence Valleys," *Geol. Surv. of Canada, Mus. Bull. No. 18* (Geol. Series, No. 28), July 23, 1915.